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CONTENTS

DETROIT, MICH.

Variation in the isotopic composition of water from natural sources.
Electrical characteristics of rubber-sulphur compounds.
The standard-cell comparator, a specialized potentiometer.
Effect of glass containers on the electromotive force of Weston normal cells.
Radio-direction finder for use on airplanes.
A basis for the comparison of X-rays generated by voltages of different wave form.
Thermal expansion of columbium.
Gum content of gasoline.
Optical and other properties of the normal formates of some group II metals.

Alkalinity of lime solutions.
Compilation of phase-rule diagrams.
Ignition of palladium compounds.
Aircraft power-plant instruments.
Aerodynamic characteristics of automobile models.
M.I.T. paper folding tester.
Revised Commercial Standard for fuel oil.
New and revised publications issued during July 1933.
Letter circulars.
Recent articles appearing in outside publications.

VARIATION IN THE ISOTOPIC COMPOSITION OF WATER FROM NATURAL SOURCES

The discovery (J.Chem.Phys., vol. 1, p. 426, 1933) that water can be fractionated by distillation suggests that water in nature, which has undergone long-continued evaporation, may have an isotopic composition different from that of circulating meteoric water. The specific gravity of pure water from each of the following natural sources was accordingly measured with the results shown. The values given represent specific-gravity increases in parts per million, the specific gravity of normal water being taken as unity.

Dead Sea.....	2.1±0.5
Great Salt Lake..	2.7±0.7
Rasorite (native borax tetrahydrate).....	6.9±0.3

This appears to be the first instance of a variation in isotopic composition in nature, in the case of nonradioactive elements.

ELECTRICAL CHARACTERISTICS OF RUBBER-SULPHUR COMPOUNDS

The first American-made submarine telegraph cable was laid by the Signal Corps of the U.S. Army from Seattle, Wash., to Sitka, Alaska, about 1900.

This was also the first long cable to be insulated with rubber instead of guttapercha. The new venture, however, was far from satisfactory. When replacement was considered shortly after the World War, the Bureau was asked to determine whether rubber was, or could be made, suitable for the insulation of a submarine cable. A survey of the situation indicated that too little was known of the basic electrical properties of rubber to justify a forecast as to its suitability for that purpose. Accordingly, in order to avoid a possible failure involving an outlay of the order of a million dollars, guttapercha insulated cable, though more expensive than a rubber insulated one, was obtained and laid in 1924.

In order to prevent recurrence of this situation at a future date a thorough and unhurried study of the electrical properties of rubber was begun by the Bureau in 1921, and has been continued up to the present time. Papers were published, one in 1925 and another in 1927, giving results of this investigation. The information obtained has already saved the Government much more than the cost of the investigation, to say nothing of the valuable data made available to industry.

Recently another chapter has been added to the record of this investigation in the form of a comprehensive report which will be published as Research Paper No. 585 in the August number of the Bureau of Standards Journal of Research.

The measurements reported in this paper were made on rubber which had been treated to remove impurities normally present in the natural gum rubber as it comes from the tree. Whereas the electrical properties of natural rubber depend on the source from which it is obtained, the properties of the purified rubber were found to be relatively constant and independent of the source.

This purified rubber was vulcanized with sulphur in a number of different proportions to form products which ranged in an unbroken series from gum rubber through the different variations of soft rubber, then through a group of materials of decreasing extensibility and increasing hardness, and ending in the various modifications of hard rubber. Accurate measurements of electrical properties were made on these products over wide ranges of conditions. The temperature was varied from -75°C. (-103°F.) at which even the softest rubber became hard and brittle, to 235°C. (455°F.), at which the rubber began to decompose rapidly on account of the heat. Frequencies were used from 60 cycles per second, which is employed for ordinary light and power purposes, to radio frequencies of 300,000 cycles per second. The results provide data which the electrical engineer can use in designing insulation whether for a power line, a radio instrument, or a submarine cable.

THE STANDARD-CELL COMPARATOR, A SPECIALIZED POTENTIOMETER

From the pioneer days when the early telegraph engineer expressed a value of electromotive force as being so many "Daniells" down to the present time, a galvanic cell of some sort has constituted the one material standard suitable for reproducing and maintaining the unit of electromotive force. The vast amount of research which has been expended on the Clark and the Weston standard cells has brought them to a high degree of perfection. The "Weston normal cell" is a standard of the highest importance in the maintenance of the volt by the national standardizing laboratories and in the intercomparison of their respec-

tive values of this unit. The portable form of the Weston cell is very widely used as a working standard of electromotive force, not only in the laboratory, but to a much greater extent as a necessary component of industrial recording and controlling devices operating on the principle of the potentiometer.

In recent years the exacting and refined absolute measurements, which are the necessary prelude to the revision of the values of the electrical units in international use, have called for augmented precision and accuracy in the intercomparison of standard cells. To meet this need, a special potentiometer has been developed at the Bureau. With it, two standard cells can be compared and a direct indication obtained of the electromotive force of one in terms of that of the other (the "reference cell") to 1 part in 10 million. The calibration error of the instrument is only a few parts in 10 million, and correction for it may be made if desired. In the design and construction of this potentiometer all available precautions and refinements have been utilized in order that it shall meet the exacting requirements of the new era in the history of the electrical units.

EFFECT OF GLASS CONTAINERS ON THE ELECTROMOTIVE FORCE OF WESTON NORMAL CELLS

The Weston normal cell is the primary standard for electromotive force. It is, therefore, important that the electromotive force of such cells should be both reproducible and constant. Pure materials are required in order to construct cells that shall have the same electromotive force within a few microvolts, and many studies have been made of the stability of the ingredients. In the past, however, but little attention has been paid to the effects produced by the glass containers. It is well known that certain kinds of glass are appreciably soluble in water and in various solutions. In addition it is known that inequalities in the acidities of the electrolyte in various parts of the cell may result in large changes in electromotive force. A series of experiments has therefore been made at the Bureau to determine whether changes in the acidity of the electrolyte produced by the slight solubility of the glass walls of the cell would produce appreciable changes in electromotive force. The results will be published as Research Paper No. 588 in the August number of the Bureau of Standards Journal of Research.

It has been found possible to accelerate the experiments by adding samples of glass in powdered form to the mercurous-sulphate paste. The effects of the powdered glass have been found to parallel the behavior of standard cells, prepared in the ordinary manner, over a much longer period of time. Various chemical compounds have also been added to the paste to test their effect on the electromotive force of the cells. The effect of the various added materials has been found to be surprisingly large, and as a result of the investigation the glass containers have been redesigned with a view to improving the constancy and portability of the cells.

RADIO-DIRECTION FINDER FOR USE ON AIRPLANES

The navigation of airplanes in fog or under conditions of low visibility is becoming more and more dependent upon the use of directional radio devices. As used in this country, directional radio equipment takes two forms: (a) the directive range beacon used on the established airways, requiring no directional radio equipment on the airplanes using the service, and (b) the direction finder, used on airplanes engaged in cross-country flying independent of the airways. The use of the direction finder on airplanes has not been extensive. There has, however, been increasing demand for a direction finder designed specifically for airplane use. The Bureau, in its capacity as the research division of the Aeronautics Branch of the Department of Commerce, has developed a simple direction finder for this purpose.

Recent flight tests made by the Bureau have shown the complete practicability of the device. The direction finder uses visual rather than aural indication, and has no moving parts except the rotatable loop antenna. Positive visual indication right and left of course is given, as well as direction sense (i.e., freedom from 180° ambiguity), without special manipulation by the pilot. The characteristics of the incoming signals are not destroyed, thus allowing simultaneous utilization of the incoming signals for message reception as well as for direction determination.

This direction finder operates on any received station; and uses any receiving set, which may be the regular receiving set already carried by the airplane. It is only necessary to supply a small loop antenna and a compact

converter unit. This converter unit furnishes a current of such a nature that an instrument shows a zero-center deflection when the heading of the airplane coincides with the direction of the station being received, and deflects to the right or left according to the departure of the airplane heading from this direction.

An interesting feature of the direction finder is its operation under conditions of bad atmospheric ("static") and ignition interference. When on-course signals are received there is little effect, and when off-course signals are received, any change in the indication tends toward an on-course indication. No violent kicking of the course indicator occurs.

The model recently tested weighs about 10 pounds, and is about 6 by 8 by 10 inches in size; both weight and size can be considerably reduced through mechanical refinement.

The direction finder depends for its operation upon the production of 2 modified figure-of-eight space patterns from 1 loop antenna, switched on alternately. For a given position of the loop antenna with respect to an incoming radio wave a zero-center course indicator is made to deflect to the right in proportion to one field pattern and to the left in proportion to the other. The switching frequency is high so that the net pointer deflection is the difference of these 2 and is at zero center when the 2 are equal, swinging right or left depending upon whether the first or second deflection is the greater. (This is determined by the direction of the incoming wave.)

The possibility of error from a change in the component parts of the direction finder is remote, since the converter unit does not depend for accuracy upon the amplification of a vacuum tube, or the balance of the amplification of two tubes. A failure in the radio-receiving set cannot introduce a course error. There are no mechanical rotating parts, which makes for lower cost and increased dependability.

The most advantageous feature of this direction finder is its almost completely automatic operation. The loop antenna does not require any careful tuning or phasing operations, since it constitutes the sole means of pick-up for the reception of transmissions.

The direction finder was installed and tested on an airplane at the College Park, Md., experimental field. Test flights were made between Washington and Baltimore, observing on

the broadcasting stations of those two cities. In these test flights the direction finder was used as a homing device. The operation of the direction finder was entirely satisfactory, indications right and left of the heading of the aircraft being very steady and definite. On passing over the stations toward which the flights were made, positive localizing action was given by the reversal of the action of the course indicator. The pilot experienced no difficulty either in accurately following the indications of course, or in locating the transmitting stations, although the locations of the stations toward which the flights were made were unknown to him. At normal volumes, a 10° variation of heading, right or left, producing full-scale readings right or left on the course indicator; this variation can be readily increased or decreased as desired.

This direction finder was designed primarily for use on airplanes, where dependability, ease of operation, sensitivity, and compactness are of primary importance, but it is also adaptable to marine use. It may be used as a homing device or for position finding by means of cross bearings.

A BASIS FOR THE COMPARISON OF X-RAYS GENERATED BY VOLTAGES OF DIFFERENT WAVE FORM

In the use of X-rays for the treatment of disease, progress has been retarded because of inability to adequately describe the radiation used on a patient. While it was possible to establish a satisfactory technique for certain treatments in a given hospital, it was usually impossible to describe the conditions sufficiently well for adequate reproduction elsewhere. This necessarily restricted the dissemination of vitally needed information. Studies at the Bureau, however, have shown a direct relationship between the effective voltage applied to an X-ray tube and the kind or quality of X-rays emitted. Measurement of the effective voltage is made possible by means of a high-resistance voltmeter developed at the Bureau for use with X-ray generators. The present clinical methods of voltage measurement have been found to be not only meaningless but frequently misleading in determining X-ray quality and, hence, are responsible for much of the confusion in describing medical treatments. Results which will be published in the August number of the Bureau of Standards Journal of Research as Research Paper No. 592,

cover an investigation of most of the common clinical X-ray generators and give what appears to be conclusive evidence that the effective voltage measurement provides an adequate description of X-ray quality.

In the present investigation, when controlling the X-ray generator by customary means (peak voltage and average tube current), mechanical rectifiers and kenotron rectifiers are found to differ in X-ray output by as much as 20 percent. The quality of penetration of the radiation is likewise found to vary over wide limits. One mechanical rectifier and three kenotron rectifiers, when given equal X-ray emission for a given filter, are found to emit X-ray beams of the same quality, regardless of the peak voltage. A "constant potential" generator, operating at some voltage considerably lower than the other generators, is found for any given filter and intensity to furnish the same quality as the other rectifiers.

However, in the case of all five rectifiers, it is found that, for equal effective (root-mean-square) voltages applied to the tube, the X-ray emission for the same filtration is about equal, both as regards quantity and quality. It is thus possible to reduce all radiations to terms of radiation excited by constant potential which in itself is always characteristic of the voltage.

Accordingly, "constant potential" radiations may be referred to as a base or a standard, in terms of which other radiations may be expressed. Effective (rms) voltages are measured by means of a 150-megohm shielded resistor which does not draw enough current from the generator to disturb its operation.

THERMAL EXPANSION OF COLUMBIUM

Columbium is one of the rare metallic elements that is coming into prominence at the present time. Although it was discovered in 1801, it has become available in appreciable quantities only during the past few years.

In 1929, Balke published an article in which he described the preparation of columbium and indicated its applications. He states that there seems to be no question of the great value of tantalum and columbium in the construction of vacuum tubes. These metals may be of value because of their ability to absorb gases. He also states that columbium can be stamped or drawn with or across the grain without serious danger of splitting, and

its ability to spotweld either to itself or to other metals, when soft-annealed and free from gas, is quite unusual.

At the Bureau, measurements have been made on the linear thermal expansion of a rod of columbium containing 0.93 percent tin and 0.26 percent iron. Data were obtained at various temperatures between -135° and $+305^{\circ}$ C. (-211° and $+581^{\circ}$ F.). The following equation was derived by the method of least squares:

$$L_t = L_0 [1 + (7.06t + 0.00144 t^2)10^{-6}]$$

In this equation L_0 represents the length of a specimen of columbium at 0° C. and L_t the length at any temperature t between -135° and $+305^{\circ}$ C.

The coefficient of expansion increases regularly with temperature. From 0° to 100° C. the average coefficient of expansion is 7.2×10^{-6} per degree C., approximately 35 percent less than the coefficient of expansion of ordinary steel. This metal therefore seems likely to be useful in apparatus or appliances where moderate expansion is required.

Research Paper No. 590 in the August number of the Bureau of Standards Journal of Research will give more details of this work, including a table of the coefficients of expansion of columbium over various temperature ranges.

GUM CONTENT OF GASOLINE

When a cracked gasoline is evaporated to dryness, the weight of residue per unit volume of gasoline depends upon the volume which is evaporated and upon the temperature at which the evaporation takes place. Since evaporation in the engine manifold occurs over a wide range of operating conditions, and since the amount of gum formed is dependent upon the conditions during evaporation, no significant laboratory method for the determination of gum content can be established without quantitative knowledge of the effects of variations in the evaporation procedure.

A general evaporation procedure has been developed at the Bureau in which emphasis is placed on drying the gum residue to constant weight. Variations in time of evaporation were effected by accelerating the rate of removal of the gasoline vapors by means of an air jet through which air passed at various rates of flow. It was found that the weight of gum obtained decreased rapidly with increase in air flow up to a certain rate.

Beyond this point a further increase in air flow appeared to have a negligible effect. The investigation of the effect of volume evaporated indicated that the gum content per unit volume decreased as the volume evaporated was decreased. The relative gum content of any two gasolines was, however, found to be independent of the particular volume evaporated. The effect of concentration of the gum-forming constituents was investigated by making measurements on several gasolines diluted with various percentages of a gum-free gasoline. The gum content per unit volume of undiluted gasoline evaporated decreased with increase in the dilution, but the relative gum contents were found to be independent of the extent of dilution. A study of the effect of temperature of evaporation on the weight of gum obtained indicated that the gum content decreased with increase in temperature. However, the relative gum contents were independent of the particular temperature of evaporation employed.

In conclusion, it has been found that when evaporation is assisted by sufficient air flow, the relative gum contents of a series of gasoline are independent of the volume evaporated or of the temperature of evaporation. Accordingly, an air-jet method can be chosen in which any convenient volume of gasoline can be evaporated at any convenient bath temperature, and the same relative gum contents for a series of gasolines will be obtained as at any other chosen bath temperature and volume evaporated. Results by this method as regards gum deposition in the engine should have the same significance as results at any other temperature and volume evaporated.

OPTICAL AND OTHER PROPERTIES OF THE NORMAL FORMATES OF SOME GROUP II METALS

The Bureau will publish as Research Paper No. 587 in the August number of the Bureau of Standards Journal of Research, values for the refractive indices, optic axial angle, elongation, dispersion, and interference figures for the normal crystalline formates of calcium, strontium, barium, magnesium, zinc, and cadmium. The crystal system and habit are likewise given. The presentation of data of this type for series of organic compounds makes the polarizing microscope available as a means of identifying these compounds, with added convenience and economy of time as a result.

The densities, and the solubilities in water from 0° to 100° C., frequently useful in the separation or identification of compounds, are also given for these formates. The solubilities all increase with increasing temperature. The formates of calcium and barium in equilibrium with the saturated solution are anhydrous over the entire range; those of magnesium and zinc are the dihydrated salts. Strontium formate shows a transition from the dihydrate to the anhydrous salt at 72° C., and cadmium formate shows a similar transition at 66° C.

The system magnesium formate water was investigated, and a eutectic mixture was found containing 14 g of magnesium formate (calculated as anhydrous salt) per 100 g of water at -5.05° C.

The accuracy of the various determinations is evaluated, and is discussed in connection with previously published work on these compounds.

A relationship of the molal concentrations of the salts in saturated solutions at various temperatures, an adaptation of Dühring's relation, is also discussed.

ALKALINITY OF LIME SOLUTIONS

The chemical utilization of lime has developed to such an extent that about half of the country's production of lime now goes into manufacturing industries. Many chemical processes involve the use of aqueous solutions of calcium hydroxide and are concerned with reactions wherein saponification, hydrolysis, causticization, coagulation, and neutralization play an important part. The control of such reactions often requires information on the alkalinity of the lime solutions. An investigation was, therefore, undertaken at the Bureau to secure fundamental data relative to the strength of calcium hydroxide as a base.

Measurements of the pH of calcium hydroxide solutions at 30° C. over the concentration range 0.050-1.199 grams CaO per liter were made, using the hydrogen electrode in conjunction with the saturated calomel half-cell, correcting for the potentials of the liquid junction occurring in this cell. The data permit calculation of the activity coefficients of hydroxyl ion in solutions of calcium hydroxide. As the activity coefficients are a measure of the thermodynamic degree of dissociation of the electrolyte, the values of the hydroxyl ion obtained, lying

between 0.86 and 0.94, over the concentration range studied, indicate that calcium hydroxide is a relatively strong base. The maximum alkalinity of its solutions is limited, however, by its relatively low solubility. In a saturated calcium hydroxide solution the activity coefficient of the calcium ion was computed to be 0.49. The value 1.72×10^{-14} at 30° for K_w , the dissociation constant of water, was derived from the data. A more complete account of this work will be published as Research Paper No. 584 in the August number of the Bureau of Standards Journal of Research.

COMPILATION OF PHASE-RULE DIAGRAMS

Phase-rule diagrams of systems having components of oxides melting at high temperatures (above 1,000° C.) have become of increasing interest and value to refractories' manufacturers, chemists in glassworks, enamellers, portland cement technologists, and to ceramists and silicate technologists generally. Such diagrams enable the technologist to predict how a refractory of known composition will behave when exposed to slags of known compositions, how the composition or melting temperature of glass may be altered to avoid devitrification, or what effect additions of certain impurities may have on the fusion temperature of fire-resistant materials.

With improvements in refractories for high temperatures and the introduction of the high-frequency furnace, the resistance furnace using high melting point windings, and other modern laboratory furnaces, it has become possible to investigate systems with component oxides melting at 2,500° C. or even higher. The lack of an adequate compilation of these diagrams in a publication to which reference can readily be made has been felt for some time and has led to the compilation by the Bureau of all the available phase-rule diagrams (except metallic systems) with components melting at high temperatures. The final work will comprise about 170 diagrams and will be published by the American Ceramic Society in the near future.

IGNITION OF PALLADIUM COMPOUNDS

Methods for the determination of palladium (in chemical analysis) usually require igniting some compound of palladium to the metal. When this is done in air the metallic residue always has a blue or purple

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color, instead of the gray color of palladium sponge, indicating that the metal is partially oxidized. Some methods direct that the residue be heated in an atmosphere of hydrogen to reduce the oxide, others that the residue be treated with a few drops of formic acid and dried, for the same purpose. The latter method is not always effective and the former is open to the objection that the palladium sponge absorbs a considerable quantity of hydrogen which may be catalytically oxidized to water when the sponge is exposed to the air.

It has recently been found that the foregoing difficulties can be avoided by cooling the sponge, after ignition in air, in an atmosphere of carbon dioxide, rather than hydrogen. The oxide or oxides of palladium which may form during the ignition of compounds of the metal in air are completely dissociated at temperatures readily attainable in porcelain crucibles heated with ordinary laboratory burners. If the metal is finally heated briefly in an atmosphere of carbon dioxide and allowed to cool in this gas no oxide is formed and the residue can be weighed directly, as metal.

Recent work has also confirmed that palladium can be very accurately determined by precipitating it with dimethylglyoxime, followed either by drying and weighing the compound (factor 0.3167) or by very carefully igniting it, under the conditions described above.

AIRCRAFT POWER PLANT INSTRUMENTS

A general report on aircraft instruments was prepared by the Bureau of Standards in 1921 and published as National Advisory Committee for Aeronautics Technical Reports Nos. 125 to 132, inclusive. These are, on the whole, now obsolete. Since preparing these reports the Bureau of Standards has examined and tested all available aircraft instruments, including most of the new types, and has carried on some development work largely in cooperation with the Bureau of Aeronautics of the Navy Department. In view of the importance of instruments in the operation and testing of aircraft and the general lack of available sources of information, a new series of reports on aircraft instruments is being prepared, based largely on this experience of the Bureau of Standards. The first of these, on Aircraft Speed Instru-

ments, was published by the National Advisory Committee for Aeronautics as Technical Report No. 420. The second to be completed is Aircraft Power Plant Instruments by Harcourt Sontag and W. G. Brombacher, which will likewise be published by the National Advisory Committee for Aeronautics.

In order to maintain satisfactory operation and control of an aircraft engine experience has shown it to be necessary for the pilot to know at all times the following: (a) The speed of the engine, (b) the pressure of the lubricating oil, (c) the fuel pressure, (d) the temperature of the cooling liquid, lubricating oil, or cylinder head, (e) the amount of fuel in the tank, (f) the rate of flow of the fuel, and (g) the pressure of the air or air-fuel mixture in supercharged engines. Possible failure of the engine is detected by changes in the normal value of some of the quantities. Thus, failure of the lubricating system is indicated either by a drop in the oil pressure or a rise in the oil, cooling liquid, or cylinder temperature.

The instruments used to measure these quantities are known respectively as (a) tachometers, (b) oil and (c) fuel-pressure gages, (d) engine thermometers, (e) fuel-quantity gages, (f) fuel-flow meters or indicators, and (g) supercharger pressure gages. For most of these instruments a number of types are available, because no one type completely meets all service requirements. This is best illustrated in the case of fuel-quantity gages, of which many types have been built, none of which appears to meet all service requirements.

The failure of certain power-plant instruments may also cause engine failure. A break in the line of the fuel- or oil-pressure gage will cause a loss of fuel or oil.

In this report the various power-plant instruments are described, the principle of operation given, and in cases where it appears of general interest, design data are included. Stress is laid upon the performance of the instruments. Inherent errors, methods of making laboratory tests, the apparatus for making such tests, and the performance of good-quality instruments are given in detail for each type of instrument now generally available. The tests described are in general those specified in the current Army and Navy specifications. A selected bibliography is included.

AERODYNAMIC CHARACTERISTICS OF AUTOMOBILE MODELS

In view of the possibility of obtaining improved fuel economy by streamlining an automobile body and the trend of design in this direction, it appeared desirable to assemble the material available as a result of wind-tunnel tests at the Bureau. This has resulted in Research Paper No. 591, which will be published in the August number of the Bureau of Standards Journal of Research. The tests, although few in number, extend intermittently over a period of 10 years. The relative values of the drag coefficients serve to give an approximate indication of the progress achieved in reducing the air resistance of the automobile body during this period.

The tests were routine in character and because of limited time no attempt was made to extend them for the purpose of determining the "best" shape. In all cases the measurements were made using the suspension method, the models being swung from light steel wires secured to the roof of the wind tunnel. The wind blowing on the model caused it to deflect a distance which was measured. The total drag corresponding to a given wind speed was computed from the weight of the model and the deflection. A correction was applied for the drag of the supporting wires. The effect of the ground was represented by testing the models near a large platform.

In the tests, the drag coefficients were found to vary from 0.0018 lb./ft²/mph² for the model representing an automobile of 10 years ago to 0.0014 for the model representing an automobile of the present. Elimination of the fenders and other projections together with pronounced fairing of the body of one model gave rise to a drag coefficient of 0.0006. Lateral and longitudinal forces were also measured in some cases. In these cases the lateral force was found to vary approximately as the angle of the relative wind if this was less than 20° to the direction of motion of the automobile. Very little variation in longitudinal force coefficient was observed in this range.

M.I.T. PAPER-FOLDING TESTER

The ability of paper to withstand repeated creasing or folding is generally considered one of its most important properties. In recent years a testing instrument, known as the "M.I.T. folding-endurance tester", has

attracted some attention because of the simplicity of its design.

At the instance of certain standardizing bodies the Bureau has recently made a study of a number of these testing instruments. The instrumental variables which might conceivably have a significant effect upon the results are the tension of the specimen, the variations in the tension during the folding cycles, the rate of folding, and the curvature of the small surfaces over which the paper is bent. It was found that differences in speed which might ordinarily be encountered did not have an appreciable effect on the results. The changes in tension during the folding cycle were found to be sufficiently large to necessitate taking them into account in the study of this type of testing instrument. The investigation indicated that correct curvature of the small surfaces over which the paper is bent is particularly important, since differences in this respect affect both the constancy in tension and the severity of the fold.

Comparative tests were also made between an instrument of this type and another type of folding tester, the Schopper instrument, which has been used for many years in testing paper. No correlation was found between the two sets of tests.

An article published in the June 1 issue of Paper Trade Journal contained the detailed results of this study and a suggested method and procedure for this type of folding tester. The Bureau has a limited number of reprints available for free distribution.

REVISED COMMERCIAL STANDARD FOR FUEL OILS

Commercial Standard CS12-33 on Fuel Oils (second edition) which was released by the Bureau last month, covers the important characteristics essential to satisfactory burning oils. Six distinct grades are described with limits as to flash point, water and sediment, pour point, distillation range, and viscosity. Experience has indicated the necessity of limiting the above characteristics in order to provide for the satisfactory burning of fuel oils, which, before the appearance of definite grade standards, was limited only by gravity—an index now looked upon as a very poor indicator of volatility or viscosity.

In addition to the above requirements there are some oils used for heat treatment and in glass and cera-

mic furnaces, and other special uses, where a low sulphur requirement is necessary. To meet this special need the second edition of this standard carries a table showing sulphur content of each grade that may be used by the purchaser of these oils.

The standard was originally published in 1929 as the Commercial Standard for Domestic and Industrial Fuel Oils CS12-29, but upon recommendation of the standing committee it was revised and with some minor changes was recommended for acceptance under the abbreviated title of Fuel Oils, CS12-33.

Endorsement of the revised standard was received from practically all the more important oil refiners, many distributors and organized consumers, together with practically all the burner manufacturers. Accordingly, the revised standard was made effective May 1, 1933.

The pamphlet, in addition to the standard specification, includes a list of acceptors and a brief history of the project. Copies can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., at 5 cents each.

**NEW AND REVISED PUBLICATIONS
ISSUED DURING JULY 1933**

Journal of Research¹

Bureau of Standards Journal of Research, vol. 11, no. 1, July 1933 (RP nos. 573 to 583, inclusive). Price 25 cents. Obtainable by subscription.

Research Papers¹

(Reprints from May 1933 Bureau of Standards Journal of Research)

RP549. Screw micrometer gages for rubber specimens; W. L. Holt. Price 5 cents.

RP550. A resistance-coupled amplifier for measuring ionization currents; L. F. Curtiss. Price 5 cents.

RP551. "Tin-free" leaded bearing bronze; H. K. Herschman and J. L. Basil. Price 5 cents.

RP553. The effect of altitude on the limits of safe operation of gas appliances; J. H. Elsemann, F. A. Smith, and C. J. Merritt. Price 5 cents.

RP554. Isolation of ethylbenzene from an Oklahoma petroleum; J. D. White and F. W. Rose, Jr. Price 5 cents.

RP555. The flexometer, an instrument for evaluating the flexural properties

of cloth and similar materials; H. F. Schiefer. Price 5 cents.

RP556. A method of exciting resonant vibrations in mechanical systems; L. B. Tuckerman, H. L. Dryden, and H. B. Brooks. Price 5 cents.

RP557. Conditions affecting the freezing temperature of silver; W. F. Roeser and A. I. Dahl. Price 5 cents.

RP558. Long-wave arc spectra of alkalis and alkaline earths; W. F. Meggers. Price 5 cents.

RP560. Critical solution temperatures of mixtures of gasoline, ethyl alcohol, and water; O. C. Bridgeman and D. W. Querfeld. Price 5 cents.

Circulars¹

C403. A discussion of some of the principles of acoustical insulation; V. L. Chrisler. Price 5 cents.

Simplified Practice Recommendations¹

R2-32 (3d ed.) Bedsteads, springs, and mattresses. Price 5 cents.

Commercial Standards¹

CS12-33 (2d ed.) Fuel oils. Price 5 cents.

Commercial Standards Monthly¹

Commercial Standards Monthly, vol. 9, no. 12, June 1933. Price 5 cents. (This publication was discontinued with the June number.)

Technical News Bulletin¹

Technical News Bulletin No. 195, July 1933. Price 5 cents. Obtainable by subscription.

LETTER CIRCULARS²

LC387. Graphited lubricants. *LC*

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¹ See footnote in next column.

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